A DISTRIBUTED POWER CONTROL SYSTEM

FIELD OF THE INVENTION

This invention relates generally to multi-processor computer systems and, more particularly, to power distribution and control.

BACKGROUND OF THE INVENTION

Computer systems typically comprise a number of boards (also referred to as cards or modules) on which resides the electrical components such as processors, memory, application-specific integrated circuits, etc. In powering such systems, there is typically a power system comprising one, or more, power supplies and a power distribution system, or power bus, for coupling each of the boards to the power supplies. The latter provide a variety of different voltages used in the computer system, such as but not limited to +5 volts (V), +12V, -5V, -12V, 3.3V, 1.8V, 1.5V, 48V, etc. (It should also be noted that there may be supplementary power supplies for providing a certain level of redundancy for the power system.)

Typically, such a power system provides what is referred to as "central power control" of individual voltage levels for performing maintenance and trouble-shooting of the computer system. In other words, an individual voltage level, e.g., the +5 volt level, can be monitored and adjusted for the entire computer system (also referred to as a "domain"). Such monitoring or adjustment can occur either directly (e.g., via a knob on the respective power supply, or via a local system administration terminal) or indirectly (e.g., where the system administration terminal is located at a remote location and coupled to the computer system via, e.g., an intranet). Thus, e.g., it is possible to raise, or lower, a particular voltage level, e.g., +5V, to all the boards of the computer system at once.

SUMMARY OF THE INVENTION

We have observed that the power system for a computer system can be further improved by providing "distributed power control." In a distributed power control system, at least two boards of a computer system each comprise at least one voltage

regulator, for providing a regulated voltage level to the board, and a processor for controlling the regulated voltage level to the board.

In an embodiment of the invention, a computer system comprises a power supply for providing at least one voltage, a power distribution system, and N boards, or modules (where $N > 1$) coupled to the power supply via the power distribution system. Each board comprises a voltage regulator, which receives the voltage from the power supply and provides a regulated voltage to the board, and a processor for controlling the voltage regulator for varying the regulated voltage to the board.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 shows an illustrative high-level block diagram of a portion of a server embodying the principles of the invention;

FIG. 2 shows an illustrative board, or module, in accordance with the principles of the invention, for use in the server of FIG. 1;

FIGs. 3 and 4 show illustrative flow charts in accordance with the principles of the invention;

FIG. 5 shows an illustrative system arrangement embodying the principles of the invention;

FIG. 6 shows another illustrative flow chart in accordance with the principles of the invention;

FIG. 7 shows another illustrative flow chart in accordance with the principles of the invention;

FIGs. 8 and 9 show other illustrative embodiments of the invention;

FIG. 10 shows a server arrangement in accordance with the principles of the invention; and

FIG. 11 shows another illustrative board for use in the server of FIG. 10.

DETAILED DESCRIPTION

FIG. 1 shows an illustrative high-level block diagram of a portion, 5, of a server (computer system) embodying the principles of the invention (hereinafter referred to as server 5). Other than the inventive concept, the elements shown in FIG. 1 are well known

and will not be described in detail. For example, a board (or module) comprises electrical components (not shown in FIG. 1) such as stored-program-control processors, memory, etc. Similarly, the power supply comprises electrical components (not shown in FIG. 1) such as transformers, etc. Power paths 11 and 12 are representative of any one of a number of forms of electrical coupling, e.g., a backplane, wire(s), wireless, etc. Also, the elements shown in FIG. 1 only relate to that portion of a server related to the inventive concept – as such, the functions each board provides, other boards, other backplanes and signaling interfaces, etc., are not described herein. (For example, server 5 may be a multi-processor system comprising at least 8 boards, where each board provides four high-performance 32-bit processors – the details of which are not related to the invention.)

As shown in FIG. 1, server 5 comprises a power supply 10 and a number of boards, *N*, as represented by boards 200-1, 200-2, …, 200-N. It should be noted that power supply 10 is merely representative of one, or more, power sources. Similarly, each board may provide different or identical functions, which, as noted above, are not described herein. (Indeed, each board may be physically different from the other boards in terms of size, shape, etc.) Each board is coupled to power supply 10 via power paths 11 and 12. Power path 11 conveys at least one "input voltage," e.g., +48V, from power supply 10 to boards 200-1, 200-2, …, 200-N. (The term "input" is relative to a board, e.g., board 200-1.) Power path 12 provides at least one input voltage, e.g., +12V, referred to herein as a "keep alive voltage" (described below) from power supply 10 to boards 200-1, 200-2, …, 200-N. Each board comprises a power control element, e.g., power control 100-1 of board 200-1. Although not apparent from FIG. 1, it is assumed that power path 12 provides operating power to each power control element, while power path 11 provides operating power to the remainder of each board. As described further below, boards 200-1, 200-2, …, 200-N provide "distributed power control." System maintenance bus 7 is coupled to all *N* boards and illustratively uses an Inter-IC (I^2C) signaling interface. Other examples of system maintenance bus 7 may be, but are not limited to: CAN (controller-area network) bus, SPI (SCSI-3 Parallel Interface)-SCSI (Small Computer System Interface) bus, USB (universal serial bus), other serial and